Searching for Relics of Dead Civilizations

If technological civilizations are short lived, we might find abundant artifacts or relics of dead civilizations in space

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By Abraham Loeb on September 18, 2018

The rate of growth of new technologies is often proportional to past knowledge, leading to an exponential advance over time. This explosive process implies that very quickly after a civilization reaches technological maturity, it would develop the means for its own destruction through climate change or nuclear, biological and chemical wars. Rapid technological events of this type would appear abrupt in the cosmic perspective of billions of years. If common, they could explain Fermi's paradox "where is everybody?" and imply that relics of dead civilizations should be abundant in space.

When exploring habitable worlds around other stars, we might therefore find planets with burnt-up surfaces, abandoned mega-structures or planetary atmospheres rich with poisonous gases and no sign of life. Even more intriguing is the possibility that we will find technological relics flying through the Solar System with no detectable functionality, such as pieces of equipment that lost power over the millions of years of their travel and appear as space junk.

The wealth of debris in interstellar space would depend on the abundance of technological civilizations and the scope of their aspirations for space exploration. Based on Kepler satellite data, we know that about a quarter of all stars host a habitable Earth-scale planet. Even if a small fraction of all habitable Earths led to technological civilizations like our own during the lifetime of their stars, there might be plenty of relics out there in the Milky Way for us to explore.

This opportunity establishes a potential foundation for a new frontier of *space-archaeology*, namely the study of relics from past civilizations in space. Instead of using shovels to dig into the ground as routine in conventional archaeology, this new frontier will be explored by using telescopes to survey the sky and dig into space.

Naively, one might consider this research horizon as futuristic. But interestingly, the first artificial relic might have just been discovered over the past year when the Pan STARRS sky survey identified the first interstellar object in the Solar System, `Oumuamua. The abundance of interstellar asteroids with `Oumuamua's kilometer-scale length was estimated a decade earlier to be a million times smaller, making this discovery a complete surprise. In addition, `Oumuamua is more elongated than any known asteroid in the Solar System. But most intriguing is the fact that `Oumuamua deviated from the orbit expected based on the Sun's gravitational field. Although such deviations could be associated with the rocket effect from outgassing due to heating of water ice by the Sun, there was no sign of any cometary tail behind `Oumuamua, and calculations imply that its spin period should have changed significantly by the associated cometary torque, contrary to observations. Might `Oumuamua have an

artificial engine? Even if it happens to be a piece of natural rock as indicated by its lack of radio transmission, this rock appears to be very unusual by many counts.

The discovery of `Oumumua should motivate us to keep searching for interstellar debris in the Solar System. Interstellar objects may not be strictly one-time visitors. A small fraction of them may get trapped by the gravitational "fishing net" cast by the Sun and Jupiter. Objects passing close enough to Jupiter could lose orbital energy through their gravitational interaction and stay bound to the Solar System subsequently. Indeed, an asteroid occupying an orbit indicative of such origin, BZ509, was identified recently in a retrograde orbit around Jupiter.

It is impossible to use existing chemical rockets to chase down `Oumumua because of its high speed, but one can contemplate missions to land on interstellar objects which are bound to the Solar System. Although they represent a tiny minority of all the asteroids or comets in the Solar System, their interstellar origin can be identified based on their unusual orbits around Jupiter or in the case of comets – through their distinct (extrasolar) isotope abundance of Oxygen, detectable by spectroscopic observations of their cometary tail.

Finding evidence for space junk of artificial origin would provide an affirmative answer to the age-old question "are we alone?" This would have a dramatic impact on our culture and add a new cosmic perspective to the significance of human activity. Finding dead civilizations due to war or climate change will hopefully convince us to get our act together and avoid a similar fate. But it would be even more remarkable if radar imaging or flyby photography near an interstellar relic within the Solar System would show signs of an advanced technology that our civilization had not mastered as of yet. There is no better lesson to learn than the one from civilizations that had the benefit of time to develop their advanced technologies up to saturation.

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Credit: Nick Higgins